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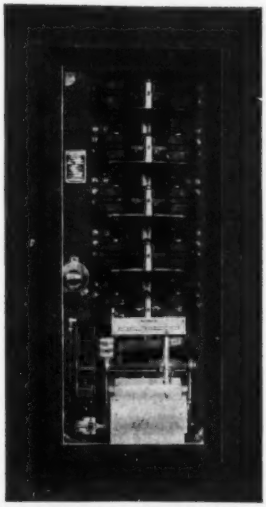

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WHAT IF IT WERE ALL GREEK TO THE ENGINEER?

BY SAMUEL CHANDLER EARLE,

Professor of English, Tufts College.

At the present moment it looks as though not only one but both French and German might be driven from the field—in the engineering school. Their first line of defense has for some time now been growing untenable; on their second line, even their supporters admit they seem at a decided disadvantage. Suppose they both fail ultimately to maintain their place in the sun; should we after all have serious cause for regret?

In the days when engineering courses were first being established in this country, there was no doubt as to what constituted a college course: the curriculum, with the exception of a few details, was fixed and the principles that determined it were entrenched in a history that reached directly back through the English universities to the schools at Canterbury and York, twelve hundred years ago. This venerable tradition, the founders of engineering schools defied as never before; but there was a limit beyond which even those innovators would not go. They had to retain a saving portion of the old "culture," or how could they themselves maintain that this new and untried business was anything more than a somewhat pretentious trade-school course? The most appropriate subjects to compromise on seemed to be French and German; consequently these modern languages (which, by the way, had but recently won recognition for themselves in company with classic languages and mathematics) came to be looked on as the ultimate minimum of collegiate respectability. And to the present day, in the minds of many the real reason for holding fast to the French and German requirement is a lingering unwillingness to betray this forlorn hope of the old tradition.

The twentieth century, however, finds engineering a fully recognized and highly honored profession, not ashamed to stand squarely on its own merits. To justify the inclusion of a subject in its course of instruction, it is no longer enough that tradition says it is an appanage of college dignity; the value of the requirement must be demonstrated in the practice of the profession. "Use" is the test now, and when the word use is transmuted into "efficiency" it becomes a term as potent to conjure with as ever tradition was.

To attempt to get at the true value of subjects by determining their "use" after graduation may be a misguided quest so long as we are considering a general collegiate course, but in the case of a professional course the problem would seem to be simpler. The engineer, especially, carries on so much of his work under the open observation and frank criticism of other and generally more experienced members of his profession that he has definite ideas as to the value of the equipment he brings to his task. Ask him if his French and German have been of use to him, and he generally interprets the inquiry as meaning, "Have you seen occasions in your professional work when it was necessary or advantageous to speak or read these languages?" To this question he feels himself competent to give a categorical answer.

Few engineers, we probably find, unhesitatingly urge the abandonment of instruction in modern languages; but if we press the point we may well suspect that in many of the instances the individual simply lacks the courage to oppose a requirement so long established, or is prescribing as good for youth, medicine he would not himself take. In any case, those who have opportunity to observe would probably agree that the majority of American engineers do not speak or read foreign languages as a part of their professional work. Seventeen years ago I personally made a questionnaire investigation and received a large percentage of negative answers. Today, Dr. C. R. Mann, in his investigation of engineering education for the Carnegie Foundation, finds conditions no different. He reports that "1,363 engineers answered the question con-

cerning the use of modern languages. Of these, 1,000, or 72.6 per cent., say that they have never found a knowledge of French, German, or Spanish essential to their professional career; 153 found foreign languages essential in general, 57 more specify German, 35 French, 73 Spanish, 43 both French and German, and 2 Italian."

Granting that we have here a fair index to the situation throughout the whole field of American engineering, there are some who believe that the returns do not warrant dropping modern languages from the curriculum, but that they indicate clearly that the subjects should be made elective, that is, not an unavoidable requirement for the degree. But when we take account of the increasing pressure every year brought to bear on engineering schools to introduce new technical subjects, and the impatience of most of our students to get into what seems "professional" work, we must recognize that making modern languages elective might well prove for the profession tantamount to banishing them from the curriculum. The question we need to answer is, Considering the ever-increasing amount of technical work it would be well for the undergraduate to do, should the study of French and German be continued as a requirement for the degree in engineering? With such a small percentage of engineers using these languages, will not the question, inevitably and soon, come before the house for settlement?

In a case of such importance the decision, it has been said, should not be left to the practicing engineer; the problem should be studied by educators and solved according to recognized pedagogical principles. With this opinion, however, I personally disagree. Doctors and lawyers, through their national organizations, undertake not only to define the ethics of their professions but to decide just what shall constitute minimum requirements for full standing. If engineers, through their national organizations, are not as competent to legislate for their profession, it is time they were.

However, it may well be that there are certain phases of the problem that others, not engineers, might call attention to that

would aid the engineer in making a wise decision. In this belief I should like to suggest a few points that may not always be considered by engineers when asked whether or not they have found their language study of value.

Minimum present attainment.—The contention of those who urge the discontinuance of the modern language requirement is not that there is nothing of value in French or German; it is rather that the students do not arrive anywhere, that after they have fulfilled the requirement they seldom can speak or even read the languages. If no real results are produced, they say, why waste the time?

As to the acquirement of ability to *speak* the language, I personally think too much stress is often put on the importance of that. In the first place it is almost if not quite beyond the possibility of American college classroom work to give more than a few of the most apt any real command of the spoken language, even if the whole time were devoted to that task. Whenever we say this, someone hastens to remind us of the rapidity with which pupils in schools abroad learn to speak foreign languages; but if we examine the cases we find that there the language studied is a live, necessary factor in the business, social, and political life of the community. It is no more wonderful for the boys in some of the districts of the Low Countries, for example, to speak one or two other languages as well as their own than it is for them to swim, skate, and manage a boat as well as to walk. It is not at all difficult for the English-speaking boy in many parts of the Province of Quebec to learn to speak French. In a similar way Spanish may become a live language in the United States before long; but at present foreign languages are not such a factor in our community life (outside the army, the navy, and the diplomatic service) as to make it easy or worth while to attempt to teach the ordinary student to speak them. If their work carries a few of our engineers into a foreign land, they will learn to speak the language with or without the aid of their college teachers.

To learn to *read* certainly is quite a different matter. That is not too great attainment to insist on after the required num-

ber of years of study. And yet, granting that students may fall short of real ability to read, must we admit that they have nothing to show for the time they have spent?

Of *grammar,* at least, they have learned something; but few would consider the knowledge of grammar in itself worth anything to an engineer, indeed that is the very thing on which most believe time has been wasted. It is the fashion just now among educators, even in speaking of English grammar, to question whether the subject has any value. This comes from the belief that grammar study has proved a failure as a producer of good English, and is in itself hopelessly dull. A strange but persistent delusion this, that grammar pretends to open a royal road to "good English." We master good English, not by learning rules, but by using English with the unwavering determination to use it well; just as we learn to run an automobile by running it, not by learning the contents of the "book of rules." Nevertheless, the rules have their value. When something goes wrong with our engine, we need more than experience in driving, we need to know the "in'ards" of the machine. From grammar we should get just such understanding of the nature and operation of language as will give us valuable first aid whenever we get into difficulties in trying to use the language. For example, even such a simple question as whether to use "you and I" or "you and me," which offers no difficulty at all to one who has mastered the elements of grammar, may long be a baffling problem to one who has learned his English by imitation. And, since few have mature grasp on even the fundamentals of their native tongue till they know something of at least one other language, time properly spent on French or German grammar should be as helpful toward the mastery of English as if it were given directly to the native tongue. To think of grammar as a "dead" science is a still more serious misunderstanding. As to its being necessarily dry to students, I am skeptical for I have to teach grammar every year to freshman engineers and I find few subjects that are so easily made interesting. It is not at all (though it has often been taught as if it were) a compilation of meaning-

less rules presented dogmatically and to be applied mechanically; it is concerned with the nature and operation of language, one of the most living objects of study, and it should lay bare as few other subjects can the fundamental processes of thought.

Furthermore, "grammar" is only a small part of language study; the chief part is the *study of words,* as separate entities and as the component parts of sentences. We have but to examine our boys as they enter the high schools, even as they enter college if they have not had well-directed language study, to note how limited their vocabularies are. Many, even of the small number of words seemingly at their command, are inaccurately understood, or have but the slightest suggestion of the richness of their full significance. Some of the scientific studies give the students accurately defined technical terms, but aside from these their opportunities for increasing their vocabularies, if they do not study languages, are limited. They hear a word till they think they are familiar with it, they meet it in reading till it no longer attracts their attention; but they seldom build up an exact and complete idea of its meaning. Their use of common slang fixes in them the habit of employing words to cover the absence of thought. An engineer need not be told how inefficient it is to attempt to do anything like exact work with nothing better at command for instruments of precision than a childishly limited number of inaccurately understood words.

Now the words that our students in the high school and in college need help in mastering are seldom Anglo-Saxon. Those of Saxon origin generally express either the simpler and more commonplace or the deeper and more inevitable ideas; their meaning is learned through the simple or the intense experiences of daily life. The words by which the mind gets its broader outlook, by mastering which it gains its subtlety and strength are largely of Latin or French origin. And whereas a child may read a word in his mother tongue many times and avoid getting any adequate idea, he cannot so read words in a foreign language if he is but moderately well taught.

If he is well taught, he becomes eager in the search for exact and full meaning and sensitive to even slight shades. When we consider the broadened outlook, the enriched vocabulary, the increased powers of discriminating thought and of effective building up of ideas by means of words, of those who have had good training in two or more languages as compared with those who have had no such training, we must admit that however much in the way of other tasks might be achieved in the time given to the study of foreign languages, there would be serious loss were these subjects given up.

Maximum Attainment Possible.—A moment ago I granted that students may fail to attain real ability to read their foreign languages. It seems to be rather generally assumed that more satisfactory results are not to be expected; but certainly there are possibilities of bettering our methods of instruction. The necessary improvement could not be brought about all at once, for the situation demands, I believe, certain radical changes; but the possibilities seem sufficiently promising to warrant making serious effort to realize them before we attempt to decide what the limits of attainment are.

In the first place, the study of modern languages is begun entirely too late in the child's life. We wait not only till the first or second year in the high school, but in many cases till after entrance to college. It is a common saying that after a certain age (eighteen, perhaps) it is difficult if not impossible to learn any foreign language; but that is not all there is to it. We have probably all noticed how common it is for children to delight in picking up foreign words, even in making up a "foreign" language of their own. It is at precisely that period—the time of beginning the *grammar grades,* let us say —that they can best commence to study foreign languages. Not as grammar study, hardly as book study, but as spoken language, in the form of dialogue and games. The interest rather than the difficulty is increased, I have found, by taking up two languages (French and German) at the same time. This work should not be allowed to increase the burden already heaped on the grade children, it should take the place of tasks

now forced on them that they could perform much more easily at a later time. The hours spent in most schools trying to teach the children to spell words they will not use for years, if ever, would be enough for this purpose. Some readjustment in the teaching would be necessary, it is true, just as there was when music, sewing, and manual training were introduced; but in any well-equipped grammar school there might easily be at least one who could teach elementary French and German, and that would be enough to direct the language work of the school. If the child is given only subject matter that is strictly within the range of his comprehension and interest, he could be taught, by spending a few moments each day for five or six years, to "speak" and to read both French and German with satisfactory readiness and accuracy. Such results are attained in some private schools, and the opportunities might well be offered to those who wish them in our public schools.

The first year in the *high school* has been considered, and would seem to be, the right time to begin the study of Latin. When the subject is taught as it is in our best schools, it should not be too difficult or too uninteresting for anyone who has sufficient ambition really to warrant his going to college. Aside from giving the growing youth some insight into the great past (from which otherwise he is so generally cut off) the chief value of the study of Latin is in building up an adequate vocabulary and in developing appreciation of exactness of verbal expression. American boys of half a century ago, like their English cousins who have been reputed to have better command of the processes of thought and of expression than American boys of the present, gained their more mature power not through the study of "English composition" but through the study of Latin.

In the same year with the Latin, a fair amount of both French and German could be read without taking an excessive amount of time, provided that subjects were chosen that are really within the comprehension and interest of the pupils.

In outlining this method of instruction, I have as yet said noth-

ing about grammar study. Inevitably the general essentials of grammar will be observed and studied in the concrete instances in the process of reading; but systematic study should not be attempted till the pupil's head is sufficiently stocked with the language itself to give meaning to his study of grammar. Perhaps the second year in the high school is the best place to begin systematic work in grammar. Even then it should start as a study of the "construction and operation" of that intensely living organism, the English language; and, taking account at every step of correspondences between the native and the foreign languages, it should thereby give the foundation on which the more minute knowledge of foreign grammars can be most naturally built.

With such a method, the results should be definite and valuable. Two years of Latin, properly studied, will accomplish much; whether this language should be continued or not is a question to be settled for each individual case. French and German might well be carried throughout the four years, even though the work had to be limited to two or only one hour per week. By the time the boy enters college he ought to be able, after his eight or nine years of study, to read both French and German, provided again the subject matter is within the range of his interests and comprehension, with adequate readiness.

If such results were accomplished in the secondary schools, the task in the *engineering school* would be much simplified. The teacher of literature, greatly to the advantage of his work, would no longer have to outline reading as if there were no literature but English. The teacher of technical subjects could assign some reading in French and German as a natural part of technical studies. This would undoubtedly put a serious burden on some members of our faculties at present, but even in these days of narrow specialization, proper team play on the part of the instructors would make the burden bearable. Some, if not all, of the foreign texts might be read under the guidance of the teacher of language, who would stress mainly a complete and accurate understanding of the subject matter. Such reading and the work in applied grammar that it would

entail might well constitute all the required work in modern languages. This would not mean the abandonment of literary French and German by the department, it would rather increase their possibilities by giving them the freedom of elective subjects.

In these days every engineering school might well offer Spanish at least as an elective. For this language there is not the need of a long period of study, as in the case of French and German, for Spanish literature has not the range or richness and Spanish language has not contributed so much to English. Consequently it should follow rather than precede the other languages. Its special justification is its "practical" value: it should be taught mainly to prepare students for an intelligent handling of the commercial, scientific, social, and political problems in which we are involved with Spanish- and Portuguese-speaking peoples. We need a large body of men adequately equipped to deal with these problems, whether they undertake work in Latin America or remain in this country.

Such accomplishments in language instruction, though they would call for no more time in the engineering school than even now is generally given to French and German, and though they would not interfere with any work in the secondary school that is needed as preparation, manifestly could not be fully realized within a number of years; but they might be well worth working toward. If a reasonable proportion of our students were given such early opportunities for study, they would develop a "language atmosphere" in which something like the linguistic attainments of European scholarship would be possible.

Relative Value for the Engineer of Language Study.—Our problem, however, is not one of absolute but of relative values: we do not have to decide whether or not the study of French and German is worth while, but whether it is worth more or less than other studies that might be pursued in the time that has been given to modern languages. Comparisons of this sort, we know, are liable to be odorous and, if they are made by one teacher placing his own subject over against another's subject,

they easily become malodorous. Nevertheless, it is well to consider certain general differences.

In the old days, school work was almost entirely book-study, that is to say, the acquisition of other persons' experience through the medium of the spoken or printed word. For two generations now the emphasis has been placed more and more on education through one's own senses and activities. The swing of the pendulum has carried so far that many think this "direct" sort the only real education. That the foundations should be solidly laid in the individual's own experience, we all in these days probably agree; and that real contribution is made only when one does something with at least a touch of originality in it, that is to say, when he again draws on his direct experience. Nevertheless, in between these two lies vicarious experience, that which we get through others, and that, after all, forms the largest part of our education. For attaining that, words and the thinking that cannot go on without words are the necessary implements. In a respectable course in engineering as taught in these days, there should be little danger that the student will not have the opportunity for a fair share of "direct" education; the danger has been that he would not receive adequate training in the kind of thinking that can lay hold on the whole funded resources of human experience.

The importance of language in the general development of the human race is suggested by the fact that the ethnologist has chosen as criteria, to distinguish between man and the lower animals, the mastery of articulate speech, and to distinguish between civilized man and the barbarian, the possession of a true written language. Upon these criteria the biologist has some interesting light to shed. We all know that much of our action is under the guidance of the lower centers, that only our deliberative acts (what we sometimes call "real thought") represent brain action. We know, further, that this deliberation is not the act of the whole brain but of only the left hemisphere. Indeed, in the words of the biologist, "All our speaking and most of our thinking are done from a spot

hardly larger than a cart-wheel dollar which lies on the side of the head just above the left ear." And if we refer to a brain-chart we find that the main portion, almost the whole, of this thinking part of the brain is made up of the language centers: "speech center," "reading words," and "hearing words."

What the results are when these centers are undeveloped we well know. We have all seen the baseball player who is wonderfully skillful on the field, who even seems a marvellously quick thinker when he has a ball in his hands, but who is in the classroom hopelessly dull. His ball-playing is entirely the result of "direct" education, in that lies his interest and to that he has given all his real attention. At the sight of a runner in a certain position he knows what to do "instinctively" and he does the right thing before one who would have to reflect could seize the situation. He is highly trained, but only in his lower centers, which unsupported by the higher centers are of little avail in classroom work. In the class he must reflect, study out what to him is a new kind of situation, and develop an entirely new line of action: the centers for such thinking have not been developed, and in all probability at his time of life it is already too late for any adequate development to take place. For the kind of achievement that college courses aim at, the active development of these centers must commence early and be continued during youth. Various means serve to this end, but none more than properly directed language study.

When the great civilizations of the ancient world were brought to an end, all Europe was overrun by barbarians. A strong race they were, of wonderful potentialities, trained by one of the finest kinds of direct education; and yet in the presence of the accumulated wealth of civilization they were helpless, for the higher centers of their brains had not been developed. For the descendants of these barbarians it took centuries to acquire the necessary brain power, but when they had once gained it the modern world began and soon the moderns had outstripped in many ways even the great ancients. When their long process of schooling began, they possessed no written language; the change was brought about in their descendants

almost entirely by the training given through the study of languages. Now it is not merely a cynical joke to call the boys that enter our secondary schools, even many that enter our colleges, barbarians. They need to have their "direct" education broadened and matured; but they also need—just as certainly as their ancestors of fourteen centuries ago needed—to develop the power of assimilating from the common experience that the human race has been storing up since its beginnings. Fortunate it is that the studies that put one directly in contact with the accumulated resources of humanity (language and literature) are the very ones that have proved so helpful in educating the higher centers.

Future Opportunities.—The discussion of the problems of foreign-language study has developed some heat of late here in America, but what shall we say of the situation abroad! Russia has changed the ancient name of her capital; French educators are hotly arguing that their youth should no longer be taught German; the Germans are striving to banish all words of French or English origin from their language even at the sacrifice of their great ideal, efficiency, at the same time that they are striving with desperate haste to learn Turkish and to teach the Turks German. Surely in comparison our language discussions seem tame and provincial.

And America, we all recognize, has been provincial. We have gloried in our three-thousand-mile water barriers, in our avoidance of entangling alliances, in our freedom from so many traditions that have long oppressed other lands. In many ways it has been a great advantage to a people of unlimited resources and with such vast problems to solve to be able to work out so largely its own salvation. But there are disadvantages, or limitations. Invention may well be provincial, in fact in a community where a large proportion have to work out their own problems invention is almost certain to be highly developed. But science is international, and we have been by no means so prolific, compared with other lands, in scientists as in inventors. In our industrial and in our civic development we have of late years many times been

shocked to find (too late it often happens) how much others could teach us.

The contrasting situation in Germany deserves serious consideration. In many industrial, scientific, civic, and scholarly ways Germany has attained not only efficiency but high international standing. The most astonishing thing about this is that, compared with her rivals, Germany has won much of this distinction surprisingly recently. "Provincial" growth has not done this. My friend the manufacturer of speed lathes tells me that if he gets out a new and particularly serviceable adaptation, within a short time someone in Germany has bought one and immediately German lathes of that model are on the market. My friend the professor tells me that of all the great scholarly works of Germans the most valuable parts are adaptations from the works of men of other nations. Obviously these critics are no friends of the Germans, but there is something to be learned even from the arraignment of an enemy. It is no secret that Germany has had her eyes open to the activities of a large part of the world and that when she has found anything of value she has been ready to adopt it.

At present it is obvious that America can no longer remain provincial, unless most seriously to her hurt. Modern science has almost swept away our water barriers; we are at present and must become more and more in the future involved with many foreign lands; and the opportunity to take an important place among the nations that shape the destinies of the world is only for us to reach out and grasp.

It is not surprising, as we have seen, that the men in Europe who have carried on the broader activities of all sorts, commercial, civic, scientific, were more certain to have at their command one or more languages besides their native tongue; the manifold and close international relations made that inevitable. But as we cease to be provincial, we shall find an increasing need of knowledge of things foreign. It is often said that "an American engineer requires nothing but what he can get in English." So far his problems have been sufficiently new so that inventive genius has largely served. Never-

theless, a few days ago a student, within my hearing, was refused permission to take a subject he had chosen for a thesis because the only authoritative treatment on that subject was in French, which he could not read; I see my chemical friends continually using German texts; and I remember a number of cases like that of a refrigerating engineer who had to work through a French treatise on heat as laboriously as a schoolboy. Sporadic cases, I admit; but certainly it is a provincial way of looking at the business to assume that for future development it is enough for the American engineer to read texts in English. Even if "everything done in other lands is reported in the American or English journals," we know that such reports are seldom as complete and trustworthy as the originals; and, what is more to the point, the real problem is often not to get the data when someone is kind enough to furnish us with it, but to get it before others have had time to profit by it.

More than all this, if American engineers are going to do their share of the world's work they cannot maintain what has been reputed to be the American attitude: that the American way is unquestionably the best and that mere foreigners ought to be glad enough to adopt anything we approve. Stories of opportunities lost because Americans have not been willing to study foreign conditions and desires are too common to need to be repeated here. It is through such study that Germany has so many times outstripped us. Even enlightened selfishness ought to teach this lesson. If, as many feel, Germany herself has in certain ways made lamentable failure in dealing with foreign peoples, it is but evidence that even she has not been able to give others the deeper understanding and sympathy that the more successful colonizing nations have learned. The greatest opportunities that lie before us Americans we can develop in proportion as our real knowledge of and sympathy for the peoples with whom we have to deal give us power.

To gain this knowledge and sympathy the best means is undoubtedly to live for a time in foreign lands. For the majority, however, foreign residence is neither possible nor desirable; and for such the one satisfactory approach to another people

is through its writings read in the original. There is no more direct or certain way of getting to the heart of a people than through familiarity with its literature (using the term in its inclusive sense), and there is no surer way of escaping provincialism than to see one's own life and the life of others in the atmosphere of intimate frankness that permeates literature.

If a man does not learn something of foreign languages in school he has (unless he happens to live sometime abroad) practically deprived himself of that opportunity for life. If we were to cease to require the study of modern languages in our engineering schools, we should be doing our utmost to deprive American engineers generally of all opportunities that demand acquaintance with any but the English language, and to put them at a serious disadvantage in dealing with all foreign problems. This moment of world-upheaval would seem a propitious time for insisting on better methods of instruction and more solid attainments in languages; but is it a time to urge a change that would threaten the whole profession with a provincialism that, even in reading a paper before an engineering society, has to grovel before a foreign phrase or proper noun?

THE FIRST-YEAR FATALITIES.

BY SADA A. HARBARGER.

Assistant in English, University of Illinois.

A recent study of the number of students at the University of Illinois who register in the college of engineering as freshmen has revealed the fact that out of one hundred students beginning the first year, only sixty-six are present at the beginning of the sophomore year. Thirty-four for some reason or other have disappeared. Since this number appears to be rather large, some inquiry into the causes for such a marked elimination seems pertinent. In my opinion, there are three possible causes which may be offered to explain the loss of thirty-four freshmen during the freshman year, viz.: (1) the lack of money necessary to pursue a further course; (2) the low mental capacity of some of the students; (3) the misconception on the part of the student of the purpose of higher education in engineering. The first two causes, I believe, affect a small number of students only; the third cause demands the most consideration.

Since the lack of money affects only a very small percentage of students, obviously it may be dismissed with brief comment. Some students with an unlimited amount of optimism and a very limited amount of capital discover during the course of tne year that it is impossible to continue their college work. Purposing to return at some future time, they leave to earn the necessary sum for further study. They consider that it is wiser to earn this money out of college than to do outside work along with their studies. These men frequently return after a year or two; consequently their withdrawal can not be considered as an elimination, but only as a temporary absence. The number affected, therefore, is not a significant part of the thirty-four per cent.

A cause which has some greater importance than the one

just noted above is that which is related to the mental capacity of some of the students. Of course, it would be a fine thing were it possible to believe that all were sufficiently endowed mentally to gain every height of scholastic training. Yet any one who has had the opportunity of observing closely a large number of students realizes that they have very different mental equipment—varying from the two to the ten talents. One is forced to admit, therefore, that, while graduation from an accredited high school might lead one to assume sufficient intellectual capability on the part of every high-school graduate to pursue successfully any amount of more advanced work, this state of things does not necessarily follow. The demands of the high-school curriculum are all that it is possible for some people to meet. This incapability does not signify that these people may not be successful in making their living or that they will not be acceptable citizens. It signifies only that they have not the mental power required to proceed with further study. Now, I do not mean by the above statements to include the slow-witted students—the plodders. The difference between them and those utterly lacking in the mental equipment necessary to take higher education is easily discovered. The recognition and admission of the varying talents of different people do not at all indicate intellectual snobbery on the part of those who make the observations but rather a square facing of the actual facts. The observers are as kindly disposed as possible toward the poorly endowed man, but they realize that the increased effort is not so profitable as it might be were it directed to fields in which the man might do the best with his mental capital. Again, this fitting of a person to his sphere need not hamper or destroy his progress; on the other hand, it should tend to increase his efficiency. And every man should have the right and the privilege of testing himself; but neither he nor the educator should say that he is utterly worthless if he can not meet the most rigid tests—only that he is not in the right place. The elimination of those who can not measure up intellectually to the requirements of a college course is natural and reasonable

and is not indicative of failure on the part of the individual concerned or the college which does the eliminating. It is a normal course of events. Here again the number affected is perhaps small; yet there are enough to demand attention.

In some points the third cause which might be offered as an explanation for the loss of the thirty-four men might have some connection with the previous cause; yet it is not my intention here to relate it to the second cause, but to assume that the mental capacity of the students concerned is such that were it not for their attitude toward college and their misunderstanding of what a college education really means, they could pursue satisfactorily for four years a college course. There is a misconception as well as ignorance on the part of some students as to the purpose and scope of college. They consider the college as a trade school where they expect to gain immediately the training necessary to demand a good salary. Every study for which they register, as they consider it, should have some direct, utilitarian purpose and should omit entirely the theoretical phases. They demand that every course should be capable of being reduced to a matter of dollars and cents. Theirs is an entirely materialistic requirement. They wish "a good living." Breadth of view, a wide range of interest make no appeal to them. The fact that college could aid them in gaining some spiritual satisfaction never enters their heads. Naturally when these practical men who have pretty definite ideas as to their wants come to college, and spend their first year in a study of subjects most of which show no direct connection with the profession which they have elected, they withdraw and go where they can secure the strictly practical training. Thus one can observe that the conscious attitude of the student is responsible for his belonging to the number who leave college either at some time during the year or at the end of the freshman year. The college does not meet *his* demands.

Again, we must recognize that the value of college training is still a debatable question; that the college as a place for equipping one for life, with a large number of people, has not

entirely vindicated itself. College education is only an experiment upon which one may spend a little time after leaving high school. It may repay further investigation; it may not. Generally we are as yet dealing with the first generation of college students, with those who have ambitions, but no background. They have no general knowledge, for example, of literature, no intuitive feeling for correct speech. They have vague longings and questioning which, with their limited experience and their lack of generations of training, they are unable to voice or to answer unaided. Now to only a few people perhaps is college a means of getting social prestige, and a place where a man may take a few years for playing before he enters upon the serious business of life. This is such an unessential reason, however, that it is worth no more than passing comment. Most students have more worthy desires for entering a college than those previously noted. They are really sincere explorers. Their difficulty is that they do not always know what they have come to see. For, through their inexperience, they have only a vague, general knowledge of just what an engineering course embraces. Since perhaps they like machinery or since they like to tinker with things, they feel that they have the qualifications for a successful engineer; or again, since they have worked during the summer or after school hours in a drafting room, on a survey, in a garage, etc., and have not found the work entirely uncongenial, they desire the opportunity of getting a knowledge of engineering which will probably take up some of the problems which they have met in their practical work. But they have had no real engineering experience that would justify them in recognizing their peculiar adaptability for an engineering course. Not long ago in a questionnaire given to 286 freshmen and sophomore students from the college of engineering the following question was asked: "What engineering experience have you had before coming to the University?" That the majority have had no actual experience upon which to judge what the whole field or any particular

branch of engineering includes is indicated by the following figures:

Actual engineering work	26
Drafting	27
Electrical work	22
Shop work	40
Garage work	23
Other forms of manual labor	20
No engineering experience	147

Is it any wonder, therefore, that some students should find by the end of their first year that they are not fitted for an engineering course and that they have no desire to pursue it further. During their first year in college their previous experience is of no service and is no criterion of what they are capable of doing.

To gain and to maintain the coöperation and the attention of the capable yet inexperienced and uninformed student, in my opinion, is the problem which confronts the college of engineering. As I see it, there are two ways whereby it might be solved: (1) By some system of extension in engineering, that is, some scheme can probably be devised by means of which the purpose and scope of a four-year college course in engineering may be made clear to the prospective freshman; (2) some scheme can be devised to inform the prospective freshman concerning the problems met with and the opportunities offered by the different subdivisions of engineering—in municipal and sanitary engineering, in mechanical engineering, in electrical engineering, etc. The book recently published entitled "Engineering as a Career" announces this purpose in its preface.* This, it seems to me, could be one means of getting the necessary information to the future first-year student.

* "The attempt of this little book is to present to youth, to teachers in the high school, and to parents or advisers, some of the facts concerning the engineering profession in general, and of different branches of engineering in particular." "Engineering as a Career," F. H. Newell, editor, Intro., p. iv.

Yet even without this previous information as a basis, there is one remedy that the college of engineering can apply more effectively and easily than the extension work. This remedy is the insistence upon the better teaching of freshmen. That is, that the instruction be given not only by one who is well informed upon his subject—I should wish to assume that every one of the corps of instructors in a college has the necessary technical information—but also by one who possesses, in addition to the technical information, the characteristics of a good teacher, sympathy, enthusiasm, insight. This teacher should have the pronounced and apparent backing of the college of engineering, whether he is appointed by that college or some other. I believe that this is especially necessary, since at the present time there is only one course—general engineering drawing—that is directly under the supervision of the college of engineering And here as far as I can judge from the comments made to me by freshmen, this department is realizing and meeting satisfactorily the responsibility that is upon it. One other means which deserves a brief comment is the freshman engineering lecture whose purpose from week to week, as I gather it from the students, is to give just that information concerning the various phases of engineering which the freshman comes to college without. Both of these means emanating from the college of engineering merit commendation and doubtless are important in retaining students in college. But those courses, language, rhetoric, mathematics, chemistry, which are taught engineering students in other than the college of engineering, are the ones which naturally create the greatest perplexities. True, frequently these other courses are taught under the head of "engineering sections." Indeed, on account of administrative reasons, I see no reason to modify this practice. There is need, however, of coöperation and frequent conferences among all those who teach the freshman engineer, irrespective of whether or not they are directly responsible to the college of engineering. These conferences would not be for the purpose of caustic criticism or for the

lowering of the standards of any course to fit some particular or especially narrow needs of the technical man. These conferences would have as their aim the acquiring of a better understanding among the teachers of technical and of cultural subjects, the discussion of the general problems connected with the most effective means of presenting subjects to students whose interests are technical, and a sincere and enthusiastic desire to give the student the proper conception of a college course, as well as the proper foundation for the work of the succeeding years.

In order to do satisfactory work the college of engineering should make a careful scrutiny of those instructors who actually teach its freshmen and should avoid those who are inexperienced or who hold themselves so aloof from their students that they get no coöperation from those under their guidance; and the college of engineering should give open recognition to those who show peculiar ability for handling freshmen. That is, it should recognize the instructor, who, aside from being proficient in his subject, has sympathy with the aims of the college from which his students come as well as sympathy with his students. This sympathy with the college does not necessarily imply exact professional knowledge of a technical course. There is no need for the one who teaches the cultural subjects to technical students to possess a strictly engineering education. But there is need of an inclination on the part of the instructor to get enough background in engineering to secure the best result; yet it is to be understood that this background shall not curtail his general range of vision.

These then are the reasons which, I think, account for the elimination of thirty-four out of a hundred men during their first year of an engineering course, and these are the remedies which I should propose. And though we can not expect to have every student who enters the university remain to graduate or can we say that the college is responsible if he does not; yet we can increase the number who do, by the active

and constructive interest of the college of engineering; by setting before the prospective student more definite information concerning a college course in engineering; and by the selection and retention of the best teachers for freshmen. By inspiration, interpretation and leadership, therefore, can the fatalities of the first year be decreased.

THERMODYNAMICS.

BY P. F. WALKER,

Dean, School of Engineering, University of Kansas.

The somewhat explosive communication in the November, 1915, number of the BULLETIN, under the caption "The Second Law of Thermodynamics," makes interesting reading and is thoroughly typical of the senior member of the writing staff. That senior member, by the way, is well known personally to the present writer, and is a prince of good fellows. He is a good physicist also, with something to say on most topics, whether in the range of his domain or not. So nothing personal enters into this discussion.

But what is this thing called thermodynamics? Most of us will agree that it is composed of the body of principles, variously expressed, which establish the relationship between heat and mechanical forms of energy. It is not heat alone. It is not a pure science, but applied, at least in so far as it may be considered in the span of years allotted to engineering students. Engineers have very definite and positive reasons for being able to determine change conditions for the two forms of energy. If heat is the primary form, then they want to be able to secure the other from it in the most economical and expeditious manner possible and to make advance determinations, or designs, in the same manner. If heat is the derived quantity, then the same conditions should prevail, with reversed action. The engineer does not care especially what names are given to his tools but he wants them ready to hand and convenient.

Nobody need quarrel with those who wish to employ such terms as "thermodynamic degeneration," and "sweeps." But why burden a vocabulary? An *assumption* is to be made. Then why not this one: that heat energy needs two factors just as work does. Say that we assume that temperature

times "something" equals heat, and see how it works out. That is the exact and approved method. Then "something" equals heat divided by temperature, and we call "something" by the name of entropy. It works out beautifully, also, and hence we have entropy as a genuine orthodox name, and we all understand it, or pretend that we do, fully as well as if we were accustomed to defining it in such illuminating terms as "thermodynamic degeneration" and "sweeps." And just as naturally as water runs down hill and spreads out on the lowlands, so is the tendency of heat energy to run down in temperature with an increase of entropy: degeneration, if you wish.

One process in reasoning in that November article deserves comment. The author asks us to go with the gas through step (*a*), compression, and then through step (*b*), free expansion, *returning to the starting point.* By his statement we go up by one path and back by another. All very well. But by what right does he proceed to calculate changes on the return by means of work values on the way up? He says no work is done on the return, but let us see.

This return trip is by the free expansion, no-work route. Is there such a thing? Of course we go back to the porous plug experiments of Joule and Lord Kelvin. What really happens? Gas acquires velocity (some, even if small) while going through the opening. How? Primarily by adiabatic expansion in the "nozzle," *doing work.* Later it comes to rest and through friction the lost heat returns. This is happening in partial degree in many millions of steam turbine nozzles every hour. What is the real route on this return trip? Simply a drop down the adiabatic and then the addition of heat, repeated several times in steps, perhaps.

Have the authors of that theory considered the situation arising when one tries to imagine an expansion with no work for any substance except a perfect gas? Free expansion reminds one of the farmer's remark concerning the giraffe, "there ain't no such animal." The curve of constant heat

is not a process curve at all, but a locus of condition points. For the imaginary perfect gas it happens to be a constant temperature line. A heavy express train makes a good hitching rack for teams, provided it is standing at a station; but under other conditions its value for that purpose is doubtful and may not accord in a *strict argument* with the primary assumption as to hitching racks. Surely any fundamental thermodynamic principle must be *independent of the working substance.* In the end, then, on the perfect gas basis with infinitesimal changes, what is this (a)–(b) journey but a three step cycle? During (a) entropy is lost as heat is extracted: during (b), which is a double step process, it returns when heat returns. There is no degeneration and the substance is just as ready to start on a cycle as before, and can keep it up ad infinitum if the supply of mechanical energy with which to compress holds out.

No one's feelings are hurt by the characterization of the three old expressions of the second law. They are interesting illustrations of the peculiar workings of men's minds. But what modern books on thermodynamics state the law in this manner, and who pays much attention to that law anyway? The authors of the original article seem to think they have made a discovery in the fact that it is connected with the expression for efficiency of the Carnot cycle. They should get up to date on methods of handling this matter in recent engineering text-books.

Beyond this point in the article the authors show plainly their restriction of ideas to pure science. When the fundamental facts of heat are mastered, facts which students might well acquire in physics, and beyond which it is stated that it is useless to go, the engineer is just ready to *begin* the study of real thermodynamics, the study of the systems for effecting heat-work interchanges. But the pure science mind does not go that far. Stop, he says, when a few heat facts are known. What use to construct a diagram on those facts? Does he know, for instance, that one of the largest builders of steam

turbines spent several hundreds of dollars last summer in the construction of a modified entropy diagram? Undoubtedly the managing designers of that company acquire hundreds of dollars worth of delight in contemplating the figures 2, 6, and 5, but have deluded themselves into believing that the diagram is of service. Had the authors of the paper put two and two together they might have discovered that since the advent of the steam turbine, writers in engineering thermodynamics have given emphasis to the theta-phi diagram, and that possibly there is a reason for it.

Will not our pure science friends, and no one values their friendship more than does the present writer, come with us to the vantage point which they have helped us to attain, and from there view the field of applied science? See here this man with his transit, another with his drawing board, another with his electric machine, another with his temperature-entropy diagram, another with his railroad, another with his factory, all striving for efficiency in a work where results mean comfort to the world and where methods must be reduced to standards; where ready application of scientific truth calls for the visualizing of principles in order that accuracy of analysis may be secured and the operating conditions of machinery determined while the machines themselves exist only in the thoroughly ordered imagination of the designer. This is the field of the engineer. See, also, in yonder secluded spot, that man. He is completing the design of his gas engine. He has dealt with many problems: degree of compression for the proper balance between maximum power and maximum efficiency; the timing of explosion; the treatment of his fuel; the utilization of exhaust heat; the heat action on his metals to avoid danger of fracture under expansion; the distribution of working forces throughout the gas cycle; economy in construction; efficiency in use of metal; these and many more. He calls to his side the office boy. "Bub," he says, "here is a letter asking that old fool question about the temperature of

ignition of gaseous mixtures. I'm busy; look it up for him."

As long as industry calls for motive power in the performance of the work of the world, so long must a large body of engineers be trained in a practical way in the vital processes involved in the interchanges of heat and mechanical energy, alias thermodynamics.

A LABORATORY EFFICIENCY TEST FOR ADVANCED STUDENTS IN CHEMISTRY.

BY DAVID F. McFARLAND,

Associate Professor Applied Chemistry, University of Illinois.

In recommending young graduates in chemistry and chemical engineering for positions in industrial laboratories and plants it is often desirable, if not imperative, to know something of their ability to do a large amount of work of more or less routine nature, neatly, accurately and acceptably, and their ability to work at times under high pressure without loss of accuracy or efficiency.

There is, unfortunately, little opportunity to measure these valuable traits with any accuracy in the usual laboratory work of the course. To be sure, much can be judged from the marked differences which are observable between the various individuals of a class in the neatness and accuracy of their work and in the promptness with which it is reported.

The daily class work can, however, scarcely be expected to afford favorable opportunity for tests of efficiency. The main object of the course is to teach fundamental principles, and standard or selected methods based on these principles. The attention of the students is focused upon these and not upon any ideas of economy of time or real efficiency of operation.

It was with a view to developing some test or series of tests that would serve to measure the different members of graduating classes, that the work herein described was begun five years ago.

It was inaugurated as a laboratory examination in a course in fire assaying in which 20 or 25 senior and graduate students are annually enrolled.

This course affords a considerable number of analytical determinations of the same general type and the student has an opportunity to learn fairly well the main details of procedure,

the sources of error and how to avoid them, and the chances for saving time and labor.

An effort is made, as the course proceeds, to get him to plan his work with a view to efficient utilization of time and to watch for improvement in the technique of his operations.

No attempt is made, however, to assume that he can be made an expert assayer in the short time allotted to the course. That is manifestly impossible and is not desirable for students of this class since very few of them expect to do any assaying after graduation.

The conditions of the "efficiency run" as the test was designated were posted several days in advance.

Each student of a squad of five was to be given four finely ground samples of ores, offering no exceptional difficulty of treatment, one day before the time of the run. He was to examine each sample carefully; make any blowpipe, vamming, or other tests which are needed to identify the minerals; and prepare a statement of the nature of the ore, its gangue and the charge which he intended to use upon it. He was allowed to stock up on materials and to put apparatus into condition, but was not permitted to make any weighings or to mix any charges.

At the time appointed for the test each contestant was given a furnace ready heated to a proper working temperature and the run was started. The control of the furnace thereafter was entirely in his hands.

The time of beginning and of the finishing of each stage of the assays was recorded by the instructor, and records were made of neatness, judgment of temperatures (checked by the instructor's pyrometer), ability to keep up fires in the furnace, smoothness of operation, exhibition of patience or impatience, evidences of miscalculation or bone-headedness, etc.

Grading was made on the following scale—Accuracy 35 per cent., Neatness 22.5 per cent., Speed 22.5 per cent., Judgment of composition and treatment of ores 10 per cent., Judgment and control of temperatures 10 per cent.

Reports were required to be neatly written upon blanks

furnished for the purpose and the complete report had to be handed in before the run was considered finished.

Accuracy was estimated on the basis of average results obtained by the men of the same class under the more leisurely conditions of their previous work.

Of all the factors involved, the one of speed appealed most strongly to the individuals making the run and from the first there was evidence of a tendency to reduce the whole test to one of speed.

With this in view, some wonderful systems of operation were devised, with short cuts that were more or less fallible and often with difficulties quite unsuspected by the authors of the systems.

The failure of these systems brought out many individual peculiarities and revealed some temporary lapses in temper and nerve control. In some cases a slight accident to the assay would serve to upset a man's whole plan and leave him floundering and apt to do many foolish things.

A fine opportunity was afforded to study the ability of the contestants to work under fire and to detect their strong as well as their weak points.

In spite of frequent admonitions to the effect that "not to the swift is the race" the sporting instinct urged a speeding up and the time records were rapidly broken again and again by successive squads and in succeeding years. An amount of work which required twelve or fifteen hours at least in their earlier career was turned out in a little over two hours by the speediest men.

The results were not so satisfactory, however, when judged from the *most* important angle of accuracy. Even when judged by the average of the current class, they were far from accurate as a rule. Moreover, penalties for gross errors of judgment, carelessness and non-control of temperatures, were more frequent than was desirable.

It was evident that the element of accuracy was rated too low, and a new scale of grading was used in this year's run, as follows:

Accuracy 60 per cent., Neatness 15 per cent., Speed 15 per cent., Judgment of ores and charges 5 per cent., Judgment of temperatures, etc., 5 per cent.

This has resulted in a very great improvement and has given some records that are highly satisfactory in accuracy as well as in other respects. The whole tone of the run has been raised and neatness has been enhanced. At the same time speed has not been lessened.

After five years of operation the test has shown itself of very great value both to the student and to his instructor.

It has fulfilled its object of affording a reasonable measure of the manipulative skill and judgment of the individual students and has been of some use in describing these qualities to prospective employers.

By far the greatest benefit, however, has come to the students themselves in arousing their interest in the planning of their work to secure efficiency, and in bringing about through this planning a much more thorough review of the whole subject matter of the course, than can be induced by any other method.

The various systems and plans of operation are vigorously discussed by the contestants before their runs and methods that succeed with one are quickly adopted by others.

During the contests interested spectators gather on the side lines and discuss the chances of their favorites' winning.

The posting of the final scores with their clear demonstration that speed without care and good judgment is a fruitless waste of endeavor in an analytical laboratory is very wholesome in its effects.

The principle of efficiency runs is one that can be utilized in many laboratory courses not only in chemistry but in numerous other subjects and it is possible that its application in a number of lines might offer the best kind of data for a rational basis of recommending men for positions.

At any rate it is commended to other teachers for trial.

DISCUSSION.

Mr. K. K. Stevens:* The article by Professor McFarland describes the application of this test to fire assay only, and may well be used in other lines of analytical work as well, in determining the efficiency of the individual. It is an interesting and valuable test to give students who have only considered the work as a means to the understanding of the fundamentals.

In my opinion accuracy should be given the highest rating, with speed next, for, unless trying for speed the accuracy should be unquestioned, and the judgment required to push the speed to the limit without decreasing the accuracy is largely controlled by the efficiency of the individual.

I would rate neatness last, because unless the maximum of neatness required is that of the average of any analytical laboratory, it would be superlative, and not absolutely necessary.

Professor R. M. Bird:† Any method of developing such efficiency as is demanded of a man in after-life is most valuable. It is also imperative that a teacher have definite knowledge regarding a man's practical efficiency in doing chemical work and handling commercial problems if he is to recommend him for employment after graduation. For a recommendation which leads to the employment of a man who can not hold down the job is unfair to the man, to the employer, to the school and to the teacher.

The test described by Professor McFarland seems to give an idea of a certain kind of efficiency. Its chief value seems to me to lie in leading the students to prepare for the test, in developing a "sporting attitude" towards the work, and in creating competition and discussion among the members of the class. The last basis of grading is much better than the first, because accuracy within necessary or desirable limits of error is a first consideration.

* Instructor in analytical chemistry, Carnegie Institute of Technology, Pittsburgh, Pa.

† Professor of Chemistry, University of Virginia, University, Va.

LABORATORY EFFICIENCY TEST.

Efficiency tests in chemistry are best when they *develop* as well as demonstrate four things, namely: a detailed knowledge of fundamental reactions, experimental skill, a knowledge of how to tackle chemical problems and look up information, and a friendly rivalry among the men. *Work directly involving tests of efficiency should be given very frequently from the beginning to the end of every course in chemical engineering—throughout four years,* varying with different courses and with as much variation as possible in each course: then the man will know his subject and we will know our man.

EDUCATIONAL ORIENTATION.

BY J. L. VAN ORNUM,
Professor of Civil Engineering, Washington University.

With reference to the "Report of Progress in the Study of Engineering Education," printed in the November number of the BULLETIN, the writer confesses himself to be one of those who regret the incorporation of "The Historical Background" as an essential part of the report. The reason for this is that its presentation as an intimate part of the investigation must tend to obscure and detract from the force of the second part, which embodies the essential elements of this vital question. As outlined in succeeding paragraphs, it seems reasonable to believe that the particular direction in which educational training must be improved will essentially be to emphasize the development of mental and moral power in the student, as a personal asset; and surely the usual conception of the qualifications required for the efficiency of industrial workers does not point primarily toward that desideratum. Dexterity, steadiness, expertness, all the mechanical operative or imitative processes of procedure that typically characterize artizans and the arts, are not the attributes fundamentally required of engineers; because an automatic aptitude of muscle or brain does not necessarily contribute to proficiency in the first, second or fourth of the qualities discussed in Part II, which are given more than half in value of the attributes there listed; and it is believed that it is this trend toward the "mechanical" conception of engineering education which is mainly responsible for such unsatisfactory results as those cited in Part III. Such introductory phrases as "mechanics and tradesmen," "skilled labor," "industrial needs," and "vocational training" hardly seem to prepare the average reader to recognize the preponderant importance of a training designed to develop a conscious

realization of personal potentiality for the rational treatment of new questions or the evolution of established practice.

There appears to be a rather widespread tendency to avoid the acceptance of any considerable responsibility for discipline in those attributes discussed under the terms character, judgment, efficiency and the understanding of men, in the work of the colleges. Many practicing engineers, as well as professors, have recently expressed the opinion that these qualities are to be developed principally in professional practice. However, the writer is disposed to unequivocally accept the significant representations of Part II as entirely pertinent. The fact that the so-called human attributes (which are given a rating of 75 per cent.) have especial opportunity for development after graduation would not appear to justify the ignoring of that training, if it can be included in the undergraduate work, any more than in the case of the technical courses, which have at times been subject to a similar argument. Nor can we believe that the parental duty of fostering the potential elements of these qualities (as well as others included in the essential moral training of the child) previous to his academic experience, removes the need of such discipline during his college course. That character of training may in fact be made a most valuable auxiliary instrumentality in leading to a greater degree of mastery, by the student, of the prescribed work in engineering science and the technique of practice. It would seem that the suggestions contained in the third paragraph from the end of the "Report" really substantiate this conception. For, does not the making of "academic credit . . . to depend directly and objectively on achievement" constitute a most impressive method of inducing the youth to realize the value of his efficiency, thoroughness, accuracy, industry, and others of those attributes in varying degree, as he perceives his instructor thus discriminatingly weighing the quality of his accomplishment? And will not the actual making of "the work . . . more concrete" inevitably involve appeal to the resourceful-

ness, judgment, common sense and other personal qualities of the student himself, when the efficient instructor (repressing the very human desire to either impart a maximum of information or to display his own extensive knowledge) frequently calls upon the class for individual contributions to the elucidation of the subject in hand? Methods such as these bring results more or less crudely, haltingly and superficially, at first; but judicious leadership rapidly corrects these defects; and there is established the intrinsically momentous condition that the progress made becomes an integral part of the student's personal character, instead of partaking of the nature of an external spray that too often entirely evaporates!

It would seem, then, that those characteristics (that are really essential in supplementing the academic and technical training of the schools, and are now so clearly and forcefully presented to our consideration) must have a large place in the attention of the teacher. Apparently they do not readily admit of specific study in engineering colleges, even if there were room for this in the already overcrowded curricula. Fortunately they are of such a nature that their gradual assumption by the student can best be encouraged by giving them constant consideration in planning the method of instruction in the class-room, laboratory, draughting-room, library, and field. A study of the educational efficiency of past generations and of contemporaneous examples of note, as well as the personal experiences that many can recall, substantiate this view when the circumstances are analyzed. Those attributes constitute the most essential element in the vitalizing of technical education, as well as a profoundly essential part of the equipment of the graduate.

The very nature of the instruction required to successfully develop these complementary qualities (being indirect, and auxiliary to the patent work of the classes) makes necessary a perpetual alertness, adaptability and insight on the part of the instructor, in order to maintain it as a definitely per-

sistent influence of inestimable value. It is our duty, in the coming years, to develop this feature of education most scrupulously, even as our predecessors so successfully elaborated the scientific side of engineering education from its previously dominant mathematical character, during the last half of the last century. The writer's conception of it can be otherwise stated as an almost unconscious training of the youth, in these attributes, by method and example rather than by precept and study, as the most effective way of really *educating* him in distinction from merely imparting knowledge, facility, and a certain assurance of mind. A few examples, from the hundreds that must become a substantial part of the evolution of this essential system of discipline, may add some definiteness to the question. It would seem that the first two classes of qualities on the list (judgment, resourcefulness, etc.) can be developed, and at the same time the student's grasp of the subject be vastly increased, if, in mathematics, more study and thought be required of the members of the class upon the correct derivation and statement of a problem in its mathematical terms, and upon the precise significance and limitations of the final result, than upon the intermediate transformation and solution of those original equations; or, in physics or chemistry, if his prescribed work in the laboratory is relieved of some of its automatically rigid character, to give more opportunity to actually correlate his experimental results with the known laws and significant principles that should become a veritable part of his personal equipment; or if, in squadwork in the laboratory or field, each chief of party for the half-day is tactfully but positively led to exercise an effective control of his mates in the accomplishment of the specified task, a real training in executive ability also is thus begun. In short, it is believed that methods of procedure can be developed in every contingency in all the courses that will not only vastly increase the student's actual mastery of the scientific and technical subjects, but at the same time will give almost unconsciously, and yet effectually, a substan-

tial degree of training in those personal attributes that are now so considerably neglected and by many are regarded as hardly germane to the work of a technical school.

While its employment is not distinctly manifest to the classes, this method does require a large measure of purposeful study by the instructor in order to plan, correlate and effectuate its thorough application. Besides the present dominant training of the intellect, it really involves an intimate understanding, not only of educational (or pedagogical) principles themselves, but also of instruction in morals, using that term in its broad sense. Ethics, moral discipline, the training of the will, the development of the rational attributes, and education in morals, all are terms that have been used at various times to express that branch of discipline that is now brought anew very forcefully to our attention. It would seem that its most earnest consideration is required in order that we may successfully apply its principles in working out the harmonious blending of scientific and technical education with that of the complementary qualities in question. Perhaps its solution, as far as the future instructor is concerned, will call for the establishment of a very few graduate schools of engineering instruction where these seemingly abstruse principles and methods may be apprehended more readily and definitely by him than when his only recourse is their gradual discernment through the exigencies of teaching (or even of professional practice), as he recognizes his supreme duty to be that of truly educating his students. Whatever direction the response may take, it does not alter the very clear requirement of the profession for an augmented training of engineering students, particularly of the character specified. Our obligation is to meet the demand with sincerity and wisdom, laboring constructively for a maximum of productive power in the discipline of the schools.

EDITORIAL.

The Council of the Society has voted to hold the next meeting of the Society from June 27 to 30, 1917, at the Northwestern University, Evanston, Ill. The meeting will begin at 10:30 A. M. Wednesday, and close at 12 M. Saturday. This arrangement is made in order to avoid conflicts as far as possible with the meetings of other societies, and also to accommodate those who come from institutions having commencements on the 27th. Fourteen institutions in which the Society has a large membership have their commencements on or after June 19th.

This is the twenty-fifth meeting of the Society since it was established as Section E of the Worlds Engineering Congress held at the Chicago Exposition in 1893. It is appropriate at this time that we should consider what the Society has accomplished during this time and that the twenty-fifth meeting should be held in the same locality as the first meeting.

The report of Dr. C. R. Mann who has been making a study of engineering education under the Joint Committee on Engineering Education organized by this Society, will be ready for discussion at this meeting. This report contains a historical discussion of the subject of engineering education as developed in this country, an analysis of the present conditions and a forecast of the future of engineering education.

No more appropriate time or place could possibly be selected for the presentation of such a report. It is necessary for an organization of men and movements to take account of stock once in so often to find out what they have done; what they are doing; and the direction in which they are to develop in the future. It is evident that this meeting will prove an occasion of this kind for engineering education. Also it would be well to have at this meeting an analysis of the work of the Society since its organization, its effect upon engineering education, an analysis of its present methods and aims, and some prediction as to the future place and work it is to occupy in the development of engineering education in this country.

COLLEGE NOTES.

University of Iowa.—To meet a growing demand for chemists with the proper training along mechanical engineering lines the course in chemical engineering has been lengthened to five years. A new course in engineering and business has also been added. In this latter course 61 hours of general subjects are offered and 75 hours of specified technical subjects are required of which 33 hours are provided by the School of Commerce. Bulletins describing these new courses are available for distribution.

After considerable study and discussion the College of Applied Science has adopted a new marking system. Information concerning this is now available in printed form.

Through the courtesy of the Murray Iron Works a uniflow engine has been loaned to the department of mechanical engineering for experimental and thesis work. A building is being erected to house the automobile testing plant which has been in the shops. The new building will make the equipment available for public use. In connection with the general improvement of the university power and heating plant integrating and graphic recording apparatus is being installed to make the plant available for experimental work. At the hydro-electric plant an automatic water stage register is being installed. Besides being of scientific value information thus obtained will be used by the Keokuk plant in a comprehensive study of the Mississippi river and its tributaries. Under the direction of the department of electrical engineering the university radio station is undertaking the instruction of amateur operators by wireless. Lessons are sent out on Tuesdays and Thursdays which are followed up by correspondence.

Under the leadership of Dean W. G. Raymond a seminar course in the Valuation of Public Utilities has been established for faculty members. The course will be added to the courses offered by the Graduate College next year.

Mr. Theodore Schou comes from the Electrical Machinery

Co. of Minneapolis, where he has been chief engineer for the last five years, to take charge of the work in dynamo design. Mr. Schou is also conducting certain research work in dynamo electrical machinery. Mr. F. E. Holmes, formerly division roadmaster of the Boston-Maine Railroad, has been added to the staff of the department of hydraulics and mechanics. Mr. L. G. Dreyer, formerly with the J. I. Case Machine Co., has been added to the shop force. Professor R. E. Hutchins, of the department of mechanics, has resigned to take up engineering work with the Morgan Engineering Co. at Memphis. Professor S. M. Woodward has left for Dayton to continue his work on the flood prevention project for several months. Professor A. G. Smith, one time in charge of theoretical mechanics, more lately head of the department of mathematics in the university, died early in November after an illness of some length.

University of Michigan.—One of the most interesting developments in the department of marine engineering has been the establishment of a regular course in aëronautics. This course has been the natural outgrowth of the enthusiasm which has been felt ever since the University Aëro Club was organized some years ago, with the encouragement of Professor H. C. Sadler, head of the department of marine engineering. This club constructed a bi-plane of their own and made some systematic study of the behavior of various bodies in wind currents. With the coming of Professor Pawlowski to the University in 1912, the interest in aviation was rapidly increased. Through him, in the fall of 1913, Professor Morchis, of the University of Paris, came to Ann Arbor for a series of lectures on aëronautics. Largely as a result of the enthusiasm following Professor Morchis's visit, the first regular courses in aëronautics were offered in February of 1914. They attracted such instant attention that it seemed advisable to extend and correlate them as one of the regular groups of electives.

The work in aëronautics is under the direction of Professor

Felix W. Pawlowski, an aëronautical and automobile engineer of recognized standing. Professor Pawlowski received his training as a mechanical engineer in both France and Germany. He was one of the first students to enroll in the new courses in aëronautics in the University of Paris. Here for two years he had not only the best of opportunities for theoretical work, but built a number of machines and engaged in practical aviation. After a variety of experiences, he came to this country in 1911. After two years as a designer of automobile engines, he came to the University of Michigan to conduct the work in aëronautics. He is at present acting as consulting engineer in both automobile and aëronautical work.

The new department has already attracted men from all parts of this country and from abroad, including men from the United States Aviation Corps and from the Chilean Navy. With the increased interest in aëronautics, resulting from the large use of aëroplanes and dirigibles in the present way, the new course seems likely to prove valuable in supplying the needed training in theory and design.

Students doing graduate work in engineering are now a considerable factor in the Graduate School of the University. At the last commencement, a larger number of students took their Master's Degree in Science in civil engineering than in any other subject except English. This is doubtless due, to some extent at least, to the increased facilities for research in sanitary engineering offered by the sanitary experiment station. The special graduate work in sanitation in connection with this station was first offered five years ago. The first year there was but a single student. Last year, the fourth year of the work, there were twelve. At the present time the equipment is taxed to its very limit, and the demand is so great as to call for an extension of the station in the near future. Almost all the men who have had this work have secured immediate recognition. Among those who are at present in positions of responsibility are Dr. Henry

Vaughn, epidemiologist of the Detroit Board of Health, Frank Walker, sanitary engineer of the same board, James Fallon, sanitary engineer at Flint, Michigan, Watson Harmon, at Toledo, and Harold McGee at Jackson.

A fine addition to the already splendid equipment of the automobile laboratory is a new Cadillac cut-out chassis, which forms one of the finest demonstration models obtainable for lecture and design sections. The chassis is the gift of the Cadillac Motor Car Company.

Professor Anderson, of the mechanical engineering faculty, who is on leave of absence, will not return until next year.

Professor John Airez has been granted a year's leave of absence to act as chief munitions inspector in this country for the Allied Armies.

Professor E. E. Nare, of the chemical engineering department, who is absent on leave, is superintending the additions being made to the varnish plant of the Acme White Lead and Color Works of Detroit.

Dean M. E. Cooley, Professor L. M. Gram, and Professor Emil Lorch are engaged as consulting engineers in the construction of the new Belle Isle Bridge at Detroit. Dean Cooley is estimating costs, Professor Gram is engaged in an advisory capacity, while Professor Lorch is one of the consulting architects of the new structure.

New Mexico College of A. and M. Arts.—A. F. Barnes, dean of engineering, has been endeavoring to organize a Southwestern Engineering Society. Letters have been received from prominent engineers in the three states of New Mexico, Arizona and Texas expressing the need of such an organization. Among the men who have promised their support are Dean G. M. Butler, of the University of Arizona, Tuscon, Arizona; Dean S. H. Worrell, of the Texas School of Mines at El Paso, Texas; Professor Brenneman, of the University of New Mexico, Albuquerque, N. M.; Mr. Samuel I. Bousman, engineer for the Chino Copper Company, Hurley, N. M.; Mr. H. L. Stevens, consulting refrigeration engi-

neer, El Paso, Texas; Mr. E. H. Baldwin, of El Paso, Texas, project manager of the Elephant Butte Dam; and Mr. S. O. Andros, Albuquerque, N. M., "Chairman of the New Mexico State Directors, Naval Consulting Board."

The object of this organization will be to promote the science of engineering in the Southwest. The principal means for this purpose shall be: First, The holding of meetings for the reading and discussion of professional papers especially upon such questions as are peculiar to this region. Second, To give opportunity for social intercourse and thus establish a common interest in the welfare of the engineering profession.

Admission to this society will no doubt not only be open to practicing engineers, but opportunity to join will be given to any person so connected with engineering as to qualify him to cooperate with engineers in the advancement of professional knowledge.

It is planned in a short time to call a meeting of those engineers that have shown interest in the matter and at such a time draw up tentative plans and program for a general meeting to be held at a suitable place at which time final organization can be effected.

In the meantime any one interested in the promotion of such a society or who has any suggestions as to scope or ways and means of organizing the same will communicate with the dean of engineering, State College, N. M., or any of the above gentlemen mentioned in this article.

The Ohio State University.—Provost Edgar F. Smith, of the University of Pennsylvania, visited The Ohio State University Friday evening, November 24, where he delivered a lecture before the Columbus Section of the American Chemical Society on "Robert Hare, A Pioneer American Chemist." O. R. Sweeney, for the past six years instructor in qualitative analysis, at the University of Pennsylvania, has been appointed instructor in industrial chemistry at The Ohio State

University where he formerly graduated from the chemical engineering school.

Pennsylvania State College.—Professor E. A. Fessenden, formerly of the University of Missouri, has been elected head of the department of mechanical engineering at The Pennsylvania State College, and assumed his duties September 1.

Other appointments to positions in the school of engineering are:

W. S. Hoffman, instructor in architectural engineering. Mr. Hoffman recently returned from Syria, where he taught in the American College. E. S. Marks, Jr., instructor in engineering drawing. Mr. Marks graduated at the University of Michigan, 1914. Ross Shumaker, instructor in engineering drawing. He is a graduate of Ohio State University, and has had experience in the bridge department of the Baltimore and Ohio Railroad. E. V. Howell, instructor in civil engineering. Mr. Howell is a graduate of Cornell University and has had experience with the Interstate Commerce Commission and with the New York State Highway Department. H. K. Kistler, instructor in civil engineering. Mr. Kistler is a graduate of Ohio State University with experience in Los Angeles and the Philippines and also in flood protection work in Ohio. L. W. Whitehead, instructor in civil engineering. Mr. Whitehead is a graduate of Mass. Institute of Technology. He taught in South Dakota College; was employed on the Grand Trunk Pacific Railroad and has been an assistant in railroad engineering at "Mass. Tech." In electrical engineering: G. H. Mills, a graduate of Case School, was appointed an instructor in electrical engineering. He has had practical experience with the Western Electric Company and the Long Island Lighting Company. G. D. Robinson, instructor in electrical engineering. He is a graduate of Cornell University, and also took advanced work at Mass. Institute of Technology, and at Harvard. E. B. Stavely, a graduate of The Pennsylvania State College in 1912, as instructor in electrical engineering. Mr. Stavely has had con-

siderable experience since graduation. In industrial engineering, M. N. Babcock was appointed an instructor in wood working. Mr. Babcock is a graduate of Michigan Agricultural College. Mr. R. C. Fielding, instructor in industrial engineering. He is a graduate of Purdue University and has had considerable experience with the Packard Automobile Company at Detroit in the production department. In mechanical engineering, J. W. Haney was appointed an instructor. He is a graduate of the University of Missouri. P. X. Rice, of the University of Arkansas, was elected a teaching fellow and is assisting in engineering experimentation. In the department of mechanics and materials of construction, E. W. Bascom was appointed an instructor. He is a graduate of Mass. Institute of Technology and was formerly employed on the design of reinforced concrete structures. H. W. Jarrett was also appointed an instructor in mechanics.

Purdue University.—The rapid increase in the numbers of students attending the various agricultural schools over the country, has, during the last few years, seemed to have the effect of either decreasing the rate of increase in attendance or actually decreasing the attendance in the engineering schools. The registration at Purdue this fall, however, seems to indicate that the attendance pendulum is approaching the limit of its swing. The rate of increase in the school of agriculture has not been maintained and the attendance in the engineering schools has increased. In the school of electrical engineering, 116 freshmen are registered this fall against 112 last fall. The sophomore class is somewhat larger also, while the total registration in the school of electrical engineering is 311 against 312 last fall.

With the exception of Mr. L. L. Bouton who at the end of the last school year resigned his position as assistant in electrical engineering to accept a place in the engineering department of the American Telephone and Telegraph Company, the personnel of the departmental faculty is the same as last

year. The following promotions taking effect at the beginning of the current school year have been made:

L. D. Rowell, from assistant professor of electrical engineering, to associate professor of electrical engineering; D. D. Ewing, from assistant professor of electrical engineering, to associate professor of electric railway engineering; R. V. Achatz, from instructor in electrical engineering, to assistant professor of electrical engineering.

Most of the members of the departmental faculty spent a large portion of the summer vacation period in outside engineering work. Professor C. Francis Harding, head of the School of Electrical Engineering, acted as consulting engineer for the Commonwealth Edison Company, at Chicago, reporting directly to Mr. Peter Junkersfeld, assistant to vice-president. Among the problems which engaged his attention was that of a study of the probable power requirements of the steam railways entering Chicago in the event of their electrification. Professor Alfred Still was engaged in putting the finishing touches on his new book dealing with electrical design. Professor L. D. Rowell was with the industrial control section of the engineering department of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa.; Professor D. D. Ewing was a member of the editorial staff of the *Electric Railway Journal* at New York.

The wireless station is being rehabilitated and installed in new quarters and a 2-kw. sending equipment, having an operating radius of 250 miles, in fair weather, has been purchased.

Throop College of Technology.—It is a matter of interest, not only to every one connected with scientific research, but to all educators, to learn of the establishment of a foundation for physical research at Throop College of Technology, and the selection of Dr. Robert A. Millikan to be in charge of the direction of the work. Dr. Millikan is, of course, universally recognized as one of the very leaders in the field of physical research in America, and in thus adding him to its

teaching staff Throop College assumes important rank as an institution of research. The enclosed clipping from the *Pasadena Star-News* (daily) gives further particulars, as contained in the announcement made by President James A. B. Scherer at the College assembly:

Dr. Millikan will begin his work during the present school year by giving a series of six lectures, with the following subjects: "Electricity in the Nineteenth Century," "X-Rays and the Birth of the New Physics," "The Electron—Its Isolation and Measurement," "Brownian Movements and Sub-Electrons," "The Structure of the Atom," "The Nature of Radiation." These same lectures are to be first given this year at the University of California, on the Hitchcock foundation, but at Throop college they will be merely preliminary to a permanent arrangement which Throop is to share with the University of Chicago, whereby Dr. Millikan will give three months in each session to research work at Throop—beginning next year—in collaboration with Dr. Noyes and Dr. Hale. This arrangement is made possible by the gift of $100,000 recently announced for physical research, and by the establishment of three fellowships, paying $1,000 a year to be shared by the research departments in physics and chemistry. Undoubtedly the coming of Dr. Millikan will involve the erection of a physics building corresponding with the chemistry building just completed, and there will be the closest coördination between the two departments.

Tufts College.—"Visitors' Night" at Tufts College engineering school was held this year on December 13. The purpose of this annual event is to give parents, future students, and others interested, an opportunity to see the school and its equipment in operation. Nearly 350 visitors attended and they showed their keen interest in the exhibition by staying long after the announced closing hour.

Among the exhibits were models, designs and apparatus, made or used by the civil, structural, mechanical, and electrical engineering and physics departments. This year, for

the first time, the chemical department opened its laboratories and a large number of experiments were conducted by the students. In the electrical department a new feature was a demonstration of the complete telephone system installed by Professor E. B. Rollins. Probably Tufts is the only college having such a system designed for laboratory use. It is so arranged that it shows every detail of construction and operation of two complete central offices, one a small magneto office, and the other a common battery office complete with three position switchboard, power plant, and terminal apparatus.

The mathematics department showed a room full of unique and interesting charts that presented both simple and involved equations in pictorial form.

Chemical experiments, engine indicator cards, wireless telegraph instruments, machine shop processes, and numerous other exhibits were comprehensively explained to large groups of visitors entirely by the students. The visitors found an added interest in the fact that much of the apparatus, which is of commercial size, was designed and constructed by Tufts students.

"Visitors' Night" has been an annual event for some time and proves more popular every year.

BOOK REVIEW.

Concise Technical Physics. By J. Loring Arnold, Professor of Electrical Engineering, New York University. McGraw-Hill Book Co. 1916. $6 \times 8\frac{1}{4}$, Cloth. 275 pages. $2.00 net.

A most excellent book for those desiring a short yet concise course in general physics. It is especially well adapted for use in engineering schools. Particular stress is laid upon fundamental conceptions. The statement of laws, principles, and definitions are short, definite and concise and the book contains only what can be required of every student. It has an excellent list of problems.

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